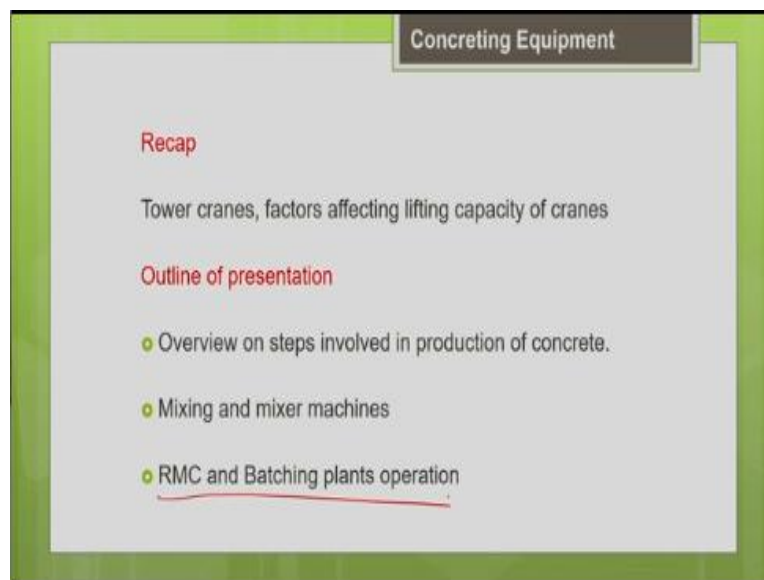


Construction Methods and Equipment Management
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Lecture – 20
Concreting Equipment (Part 1)

Hello, everyone. I welcome you all to the lecture 20 of this course, construction methods and equipment management. In today's lecture, we are going to discuss about the concreting equipments.

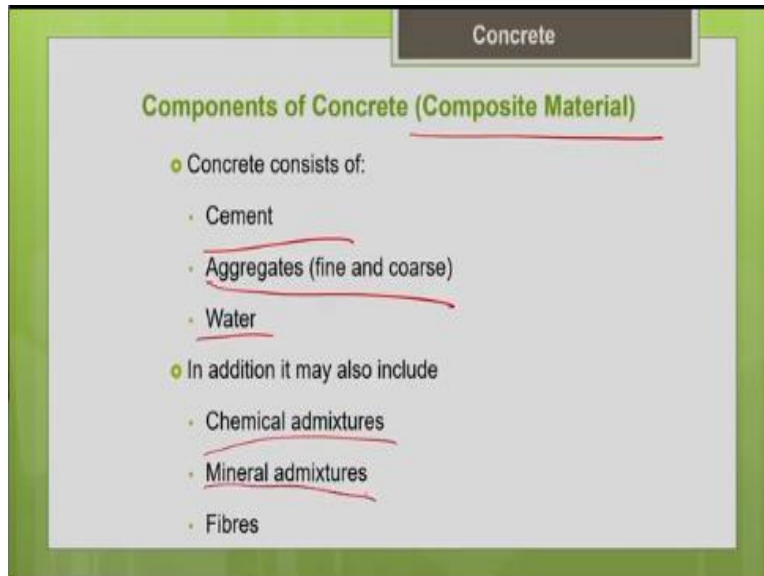
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So, in the last lecture, we have discussed about the tower cranes and about the factors which affects the lifting capacity of the cranes. So, let us look into the outline of today's presentation. In today's presentation, we are going to discuss about the basic steps involved in the production of concrete. And we will be discussing in detail about the different types of concrete mixer machines. And we will be discussing operation of the ready-mix batching plant.

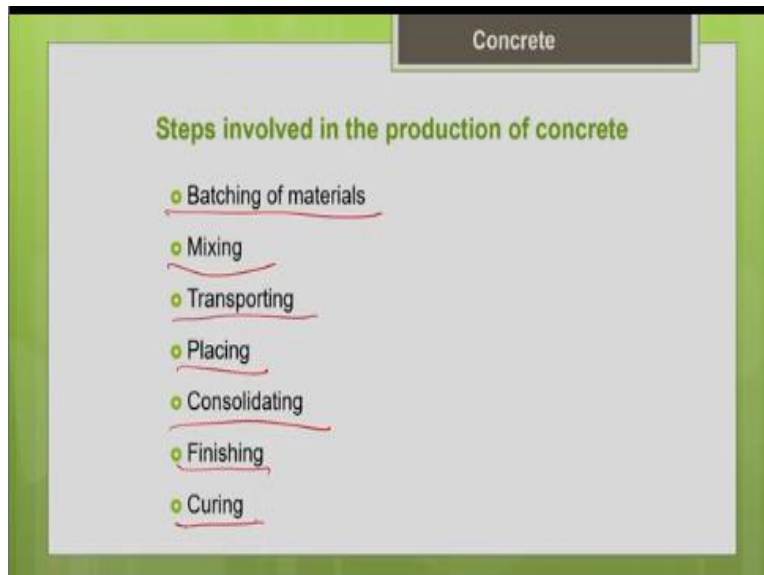
So, in this lecture, we are going to discuss much about the concrete. I assume that we might have been exposed to the concrete in any other material related course. So, we will be directly discussing more about the concreting equipment. But basically, as everyone knows, concrete is a composite material.

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It is made up of different ingredients like cement, aggregate and water. So, other than these conventional ingredients, nowadays, we use modern admixtures also, chemical base admixtures, mineral base admixtures. So, in order to improve the performance of concrete in terms of strength, workability and durability, using different types of admixtures.

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So, now, let us look into the what are all the basic steps involved in the production of concrete. So, the first thing is to produce the concrete, we need to know the mix proportions. So, we need to do the concrete mix design or mix proportioning. So, to know how much quantity of cement, aggregate and water to be added for making a concrete of desired strength, workability and durability.

So, there are standard mix design guidelines which vary from country to country. Like, for India, we have these Indian standard guidelines, we have the ISO code guidelines for that. And similarly, we have the ACI guidelines. There is American Concrete Institute guidelines and we also have the British general guidelines. So, we can follow the standard guidelines to the mix proportioning of the concrete to get your desired strength, workability and durability.

So, once the mix design is done, the next step will be the batching. You have to measure the ingredients. That is what is batching, then mix it. So, we can use the mixer machines to mix the concrete and after mixing it, transported to the require place where you need to do the concreting work or where you need to cast your concrete, then place it, then consolidate it or consolidate is nothing but commonly adopted vibration methods to eliminate the entrapped air.

So, whatever air which is in entrap during the mixing of concrete can be removed by the consolidation process. Then finally, you finish it to the require texture according to your requirement. Then the last step will be curing of the concrete to facilitate the continued hydration of the concrete, so that we can attain the desired strength. So, these are the basic steps involved in the production of the concrete. We are going to discuss all these steps one by one in detail in the upcoming slides.

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Concrete

Influence of production process on Quality of Concrete

- Concrete performance is assessed through its strength, workability and durability
- The above desired performance of concrete depends on its microstructure.
- Microstructure is determined by its composition and production process of concrete.

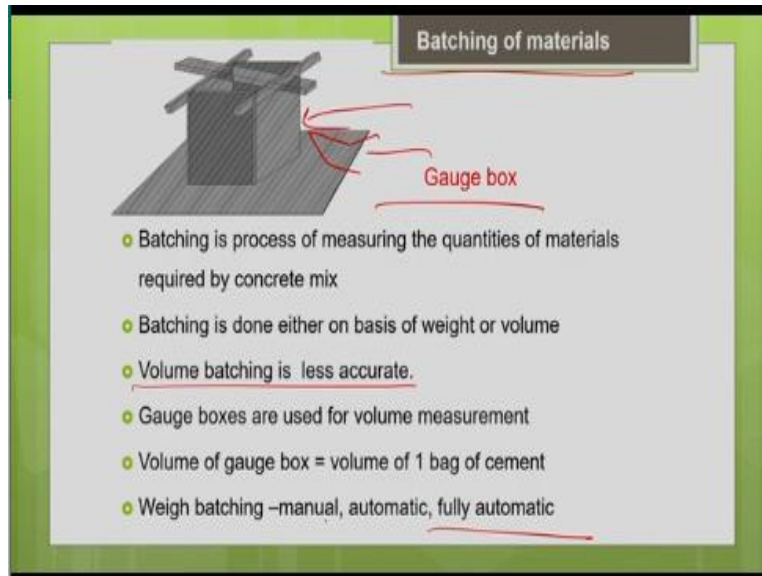
So, an important thing to be noted is that the production processes as a significant influence on the quality of your concrete. So, generally, we assess the quality of the concrete or assess the performance of the concrete in terms of its strength, workability and durability. Concrete performance is assessed through its strength, workability and durability. So, you can get your desired performance provided your concrete as desired microstructure.

So, all this strength, durability, everything depends upon the microstructure of the concrete. To get the desired microstructure, need to have a good control in the quality control in the production process right from the mix design because microstructure will depend upon the mix composition, how much quantity of aggregates and how much quantity of cement, everything is going to decide the microstructure of concrete.

So, starting from the mix design, we should have a strict control in the quantity. So, and also, how we mix the contribution, mix in such a way that you get a homogenous mix. So, there is a uniform coating of spacer on the aggregate that will result in a good microstructure. Similarly, you need to consolidate the concrete. So, that all the unwanted entrapped air is removed. So that we can get good microstructure.

So, your microstructure is going to be determined by the composition and the production process of the concrete that is why it exercise a good quality control in the production procedure of the concrete.

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So, let us start with the first step like once you do that mix design, once you know the mix proportions, you need to first batch, do the batching of the material. Batching is nothing but measurement of your quantity of material. This, you can either do it on volumetric basis or you can do it on weigh basis. Very commonly, you can see that in the project sites, people prefer volumetric only because it is very convenient to them to measure on basis volume.

They use the gauge boxes; these boxes are standard wooden boxes or steel boxes. Volume of one-gauge box equal to volume one bag of cement. So, they use this for the measurement of the ingredients of the concrete but one thing to be noted is the volume batching is less accurate when compared to the weigh batching. So, for example, the sand which we are going to use for concrete making is that, so, you are going to measure the wet sand using this gauge box.

So, you know that sand will bulk; when it is moisture, content increases. So, depending upon the fineness of the sand, more finer the sand, it will bulk more. So, due to bulking, its volume appears more but the actual weight will be less. So, if you are going to measure the sand using this gauge box, so, what will happen? You are going to, your mix will become under sanded. Because the volume may appear right but actual weight will be less because your sand is wet.

So, that is why it is result in inaccurate measurement and your mix composition of the concrete gets affected; your mix becomes under sanded. When the mix becomes under sanded, what will

happen? It will become less cohesive and that may result in segregation of your concrete. So, all these things are fixed microstructure of the concrete, strength and the durability of a concrete. So, that is why volume batching is less accurate.

To get a good quality of concrete, we should always go for weigh batching. So, batching plan if you see always the batching of the material is done on the weight basis. So, depending upon the batching plan, in some batching plans, we have fully automated system. You just need to enter the weight of the material, weight of cement, weight of aggregate, then the exact quantity of the cement will be discharged from the cement silos conveyor, belt conveyor into the mixer machine.

Similarly, the exact quantity of the aggregate will be released from the aggregate storage bins and it will be conveyed by the conveyor and carry to the mixer machine directly. So, we have fully automated batch systems available, weighing batch systems available in the model, RMC batching plan. So, there are different types of weigh batching: fully automatic or semi automatic or manual.

So, different types of batching systems are there, but one thing you have to always keep in mind that weigh batching is always accurate when compared to the volume batching. So, it is always preferable to go for weigh batching to get a good quality of concrete.

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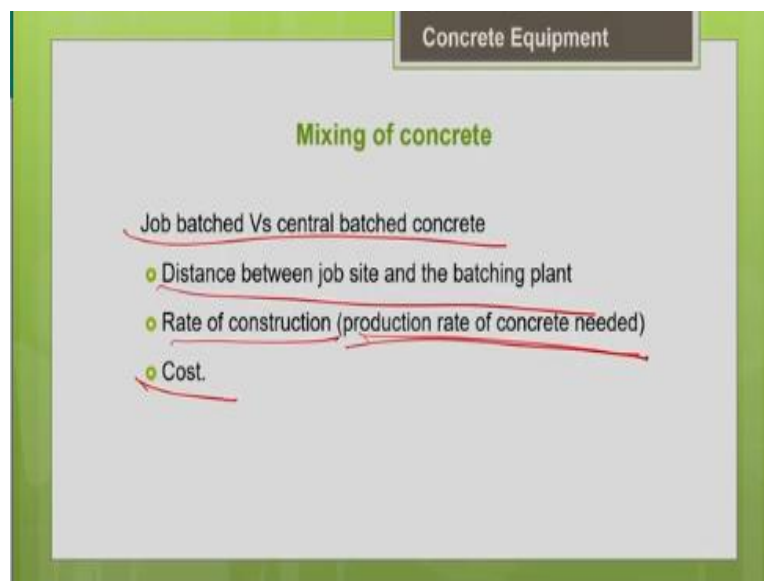


So, next is about the job batched concrete versus central batch concrete. So, the basic difference is job batched means you are going to prepare the concrete at a job site. Central batched concrete means, your concrete will be prepared in the batching plant. It will be prepared in the batching plant and it will be brought to the job site in RMC transit mixer. So, that is a basic difference between job batched concrete and central batched concrete.

So, when do we generally go for job batched concrete? How do you make the decision to go for whether the job batched or central batched? It may be depends upon the location of your project site. If your job site is located in a very remote place, where it would be very difficult for the RMC transit mixer to deliver the concrete within the stipulated time, then in that case, you have to go for a job batched concrete.

So, it depends upon the location of your job site. Similarly, sometimes, you can see that your jobs may be located in a traffic congested place. In that place also due to traffic delays, it may not be possible for the transit mixer to deliver your concrete within the stipulated time. So, in that case also, you have to go for only the job batched concrete.

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So, the decision of going for job batch or central batch mainly depends upon the distance between your job site and the batching plant. Another important thing is your rate of construction. So, how much quantity of concrete you need per hour or per day? The production rate of concrete needed

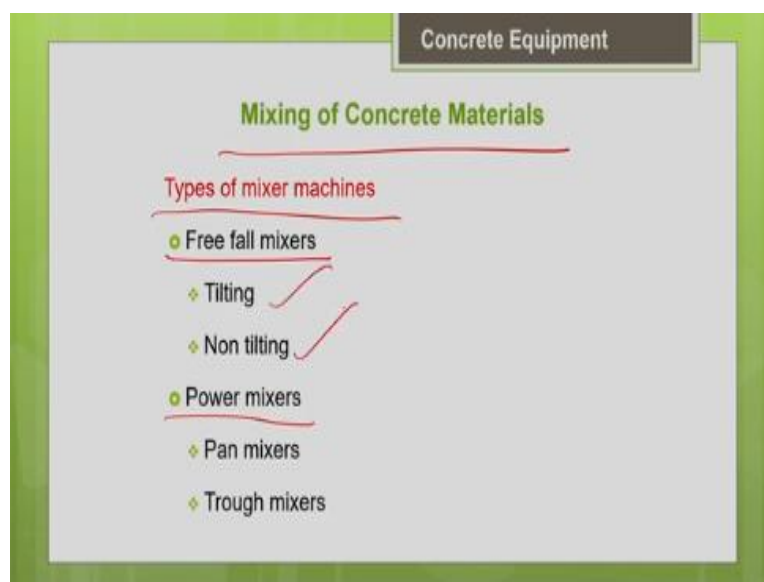
that also decides the selection of job batching or central batching. If we need huge quantity of concrete every day, the rate of construction is very high.

And the production rate of concrete needed is very high. In that case, it is always advisable to have your own batching plant at your site and make the concrete because we need huge volume of concrete on a daily basis. So, it may not be possible for the RMC batching plant to deliver to you on a continuous basis because they will be having so many customers. So, there is no assurance that you will be receiving the concrete on the continuous basis from the RMC factory.

So, if your production rate of concrete, the requirement of concrete volume needed is more, then it is advisable to have you bought batching plant at your site and produce a concrete that will be even more economical also, then on cost basis. Obviously, when compared to job batch, the central batch concrete is going to be costlier. It is manufactured in the factory under strict quality control.

So, the quality of concrete is also good when you get it from this factory, central batching plant and also at the same time, it is going to be costlier when compared to the job batch concrete. So, the economics, the budget, a project budget will also decide whether to go for job batched or central batched. So, based on all these factors, we have to make a decision whether to go for a job batched to central batched concrete.

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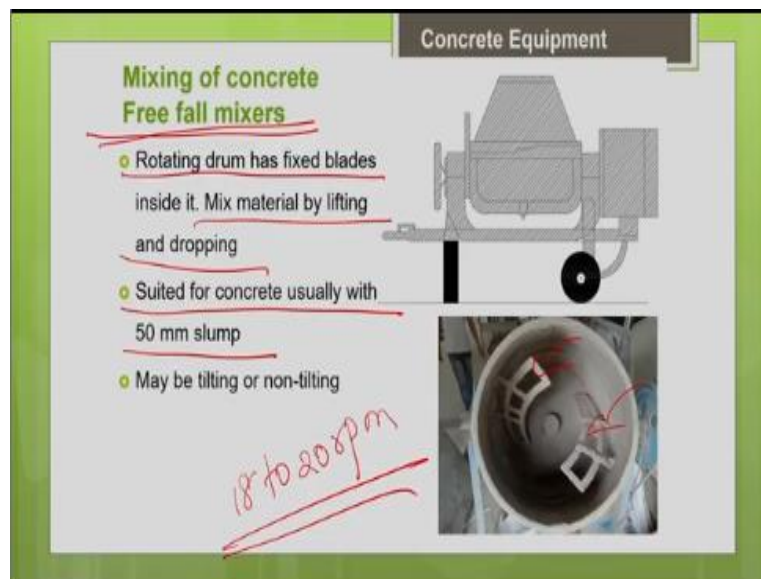


Then about the mixing of concrete: So, first, we discussed about the batching, then we move on to mixing. So, mixing of concrete, you have to spend more effort to have a homogeneous mixing of concrete. So, you should be very careful about the mixing of concrete because we should ensure that we get a homogenous mix, then only you can have a good microstructure of concrete.

As I told you, you need to have a good coating of spacer around the aggregate. So, for that, you need to ensure a homogeneous mixing. So, in some cases, you can see that people even mix a concrete with hand for unimportant works but you can see that the quality of concrete will be poor in the case. So, it is always preferable to go for the machine mixing to get a homogenous mix.

So, there are different types of concrete mixer machines nowadays available in the market. Based upon the method of mixing, there is a mechanism of mixing, you can broadly classify them into 2 categories. One is a free fall mixer; other one is your power mixer. So, in free fall mixer also is subdivided into categories based upon the discharging of concrete like tilting and non-tilting type. And power mixer depending upon the shape of the drum, you can type it into pan mixer and trough mixer. So, we are going to discuss all these types one by one.

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The first is about the free fall mixer. So, the conventional drum mixes what you see in your job site very commonly, is based on free fall mechanism. As the name indicates, the concrete here, we are going to discuss based on free fall mechanism of the material that means I can see the inside

view of the drum, you are having fixed blades. Blades fixed to the inside of the drum, you can see clearly in the picture. You can see the blades.

So, these blades, when the drum is rotating, it will help you to lift the material and drop the material at the end of the rotation. So, by lifting and dropping the material, your material gets mixed thoroughly that is what is happening. That is why it is called as free fall mixer. So, basically, your blades are lifting the material when the drum is rotated and allow it to fall at the end of the rotation. So, it keeps lifting and dropping.

So, the rotating drum as fixed blades inside it, it mix the material by lifting, dropping it. So, that is why basically this mixer machine, you should have some desired consistency of the concrete to facilitate the free fall mechanism. If the mix is very stiff or very cohesive, in that case, this mixer machine would not be compatible. So, the free fall only possible with a very stiff mix.

So, we need a slump at least 50 mm to have the free fall mechanism; suited for concrete usually with 50 slump. So, minimum 50 mm slump is needed to facilitate the free fall mechanism. So, also, this drum should not be rotated at a very high speed. The commonly adopted speed is 18 to 20 RPM. So, if you rotate it at a very high speed also, you can see that the free fall mechanism will not happen.

So, that is why we should go by the manufacturer's recommendation with respect to the speed of rotation of the concrete mixer machine. So, you have different configurations of tilting type and non-tilting type.

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So, basically in this free fall tilting type of the concrete mixers, you can see this kind of wheel arrangement, you can see. So, with this wheel arrangement, you can change the angle of inclination of the drum. So, you can change the angle of inclination of the drum with this wheel arrangement. So, that helps you to tilt the drum.

So, if you want to discharge the concrete, you can just tilt the drum, so, that we can easily discharge the concrete. So, with the tilting mixer, you can see that the discharge rate will be faster. And another important thing to be noted is; you can have a tilting hopper like this. This is called as tilting hopper. So, with the help of this, I can easily feed the material into the concrete mixer machine.

So, this will also help you to speed up the process. You can easily load the drum with the tilting hopper. You can save a time.

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So, as I mentioned earlier, the tilting mixers discharge concrete more rapidly than non-tilting. So, particularly for the concrete, the time is very critical. Once you prepare the concrete, once you add the order to the cement, what happens is, cement will start the setting that is why as early as possible, they should just place a concrete in the desired position. So, that is very important with respect to the concrete.

And another important thing is; it is a composite material. It is made up of different types of material a coarse aggregate, fine aggregate and cement. So, when you leave concrete undisturbed for some time, what happens? You can see that the heavier aggregate will settle down at the bottom. So, this is a kind of segregation. The coarse segregate will settle down at the bottom.

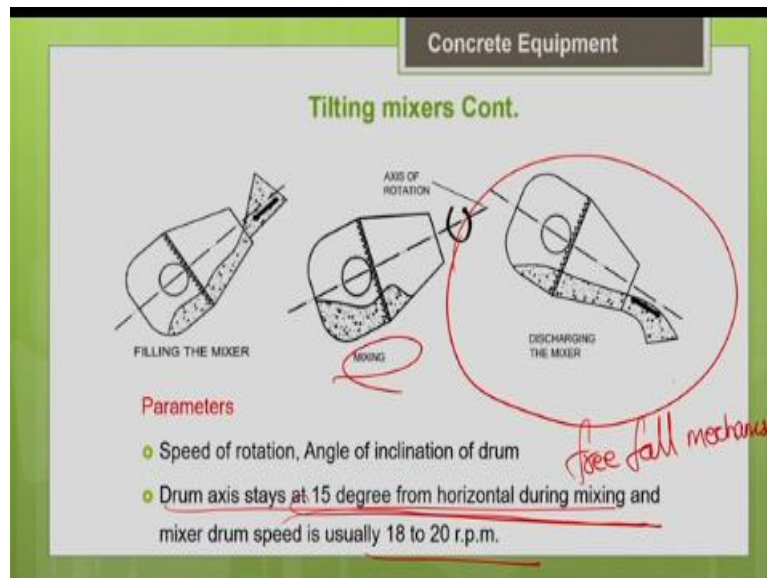
So, if it is settled down at the bottom, you will not be able to have a homogeneous mix. So, that is why we should not waste time. We should immediately; once the concrete is made, we should immediately discharge the concrete and carry it to the desired place. We should never waste time in the preparation of the concrete. That is why tilting is very helpful because its discharged rate is very faster when compared to the non-tilting mixer.

So, the chances for segregation is less when you go for tilting mixers. So, tilting mixers discharge concrete more rapidly. As I mentioned earlier, you can either feed the material manually or with a tilting hopper. As I showed you earlier, this is the tilting hopper. With tilting hopper, you can easily

speed up the loading process. So, we have wide ranges of drum sizes, varying from 140 liters to 2800 liters.

Accordingly, the concrete output will also range from 4 to 90 meter cube of concrete per hour. So, depending upon your equipment, you can choose a size of a drum.

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So, this schematic picture, it shows how the angle of inclination of the drum can be changed from loading position to discharging position. So, by rotating the weigh, you can change the angle of inclination of the drum. So, basically, based upon studies, they found that the drum axis should stay at 15 degree from the horizontal during the mixing. During mixing, it should stay at 15 degrees to the horizontal.

So, that is the desired angle of inclination with respect to horizontal during the mixing of your concrete. So, this is because, one basic thing as you know already is, if you keep the drum vertical, so, obviously, your blade will not be able to lift the material. So, you cannot keep the drum vertical and do the mixing. Obviously, you can also keep the drum completely horizontal.

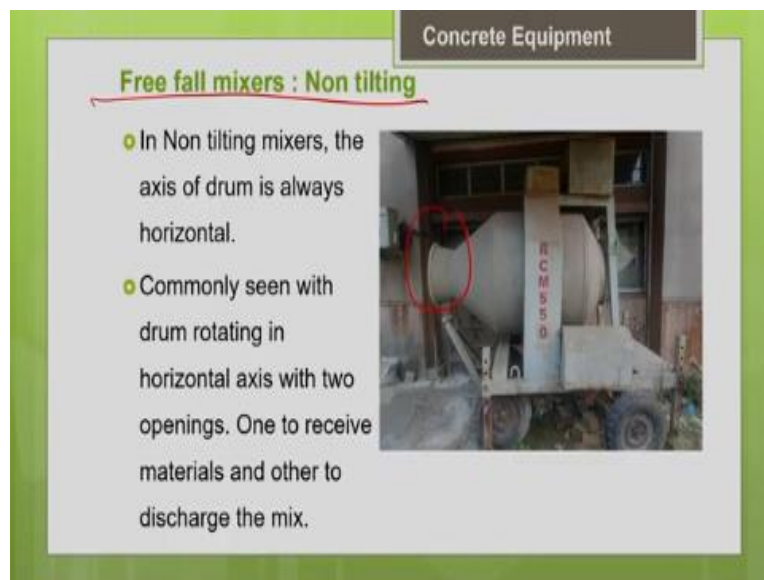
If I keep it completely horizontal with zero degree, even that is not possible, this is because; if it is completely the horizontal, what will happen is, your blades will come in contact with more

quantity of concrete. In that case, more energy is needed for lifting the entire concrete to the full diameter of the drum. So, the energy consumption is more that is to optimize energy consumption.

The preferred angle of inclination is 15 degree from the horizontal as established based on studies. So, this is a commonly adopted angle of inclination and while discharging as you know, you can completely tilt the drum and mixer's drum speed which is recommended by the manufacturer is 18 to 20 RPM. As I told you, these drum mixers are based on free fall mechanism. So, to enable the free fall mechanism, you should not rotate it at a very high speed also.

If you rotate it at a high speed, you will not be able to get the free fall mechanism. So, and also, if you rotate it as low speed also, your productivity will be less as well as you will not get a homogeneous mix. So, we should follow the speed prescribed by the manufacturer.

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So, the next is about the free fall mixes non-tilting type. Here, I cannot change the angle of inclination of the drum. You can see that the excess of the drum is always horizontal. You cannot change the angle of inclination of the drum. Commonly, you can see this with 2 openings. So, one for feeding in the material and one for discharging the concrete out. So, this is a common configuration, you can see for a non-tilting type.

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So, you can discharge the concrete out by inserting a chute into it. You can insert the chute into the opening and discharge the concrete. Generally, for non-tilting mixers, you can see that the cycle time will be more because discharging time is more. In tilting type, you can immediately destroy the concrete. The time duration needed is less. But here, the time duration needed for discharging will be more. That is why you can see that the cycle time will be more and the productivity of these mixers will be less, relatively less when compared to tilting type.

So, you can see, there is another configuration where the drum is reversible, reversible drum. If you rotate the drum in one direction, it will facilitate the entry of the material into the drum. If you rotate the drum in the opposite direction, it will facilitate the discharge of material out of the drum. So, that is called as reversible mixers. Reversible mixers are also available in the market.

You can see **(Video Starts: 00:20:31)** if you look into the inside of the drum, you can see that a spirally arranged blades are there, fixed to the inside of the drum. So, you can see the spiral arrangement of blades. The spiral arrangement of blades, you can see the blade arrangement inside the drum. So, this spiral arrangement of blades inside the drum, what it does is; when you rotate the drum in one direction, it will pull the material inside.

When you rotate the drum in the opposite direction, it will push the material outside. **(Video Ends: 00:21:06)** So, that is why by reversing the direction of rotation, I can discharge the concrete out in

this non-tilting mixers. So, the discharge of concrete can be done by inserting the chute into the drum or by reversing the direction of the rotation of the drum.

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So, this is also one more configuration of non-tilting reversible mixer. Here, you can see, there is only one opening. So, you can feed the material into the tilting hopper and you can just discharge the material outside by just rotating it in the opposite direction. So, these are also reversible mixers. When you rotate in the opposite direction, you can discharge the material out because there will be spiral blade arrangement inside the drum which facilitates the pulling in the material inside when you rotate in one direction and it will push out the material outside when you rotate in the opposite direction.

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